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consumers. Quite a number of sweet and savoury preparations with attractive shapes and sizes and with good keeping quality can be made out of the starch. These may open out new industries. There is also scope for utilizing the different by-products, chiefly for animal feeds. The materials can also be used for fermentation industries and for the manufacture of antibiotics and other valuable products. There is need for an integrated programme of pure and applied research and it is hoped that the State and the Industry will soon collaborate in organizing it.

I wish to acknowledge the collaboration of Mr. V. Balu, (*Division of Food Information & Statistics*), Dr. D. S. Bhatia, (*Head of the Food Processing Division*), Mr. R. C. Bhutiani (*Head of the Food Information & Statistics Division*), Mr. B. H. Krishna (*Head of the Food Engineering Division*) and Dr. M. Swaminathan (*Head of the Biochemistry and Nutrition Division*) in the compilation of this **Brochure**, and the assistance of Mr. K. V. Achyuta Rao, in the preparation of photographs.

Central Food Technological Research Institute, Mysore.

V. SUBRAHMANYAN,
Director.

The Sago Palm (Metroxylon sagus Rottb.)
(Courtesy : Dr. K. Biswas. Indian Botanic Garden, Calcutta.)

50. Errappa Naicker, Sago Factory,
Sandamangalam (P. O.), Namakkal (Tk.), Salem (Dt.)
51. M. Veerappa Pillai, Sago Factory,
Sellappamapatti (P. O.), Namakkal (Tk.), Salem (Dt.)
52. V. Pitchamuthu Pillai, Sago Factory,
Sellappampatti (P. O,), Namakkal (Tk.), Salem (Dt.)
53. C. Ammasi Naicker, Sago Factory,
Mallur, Salem (Tk.)
54. Sun Starch Industries, Sago Factory, Mallur, Salem (Tk.)
55. Sri Tharan & Co., Sago Factory, P. Mettur,
Mallur (P. O.), Salem (Tk.)
56. Dursamy Padiachi & Chinu, Sago Factory,
Perummannur, Mallur (P. O.), Salem (Tk.)
57. P. Kandappa Gounder, Sago Factory,
Ammapalayam, Mallur (P. O.), Salem (Tk.)
58. S. Kandapa Gounder, Sago Factory.
S. Attyapati, Pnimankaadu, Mallur, Salem (Tk.)
59. Appu (alias) K. Karuppa Gounder, Sago Factory,
Pannamarathupetti, Salem (Tk.)
60. N. A. Nalla Gounder, Thippampatti,
Panamarathupatti, Salem (Tk.)
61. N. Peria Swamy Padiachi, Sago Factory,
Panamarathupatti, Salem (Tk.)
62. Peria Swamy Gounder, Sago Factory,
Thangalpalayam Rasipuram, (P. O.) Salem (Dt.)
63. C. Chinnu Swamy & Co., Sago Factory,
Rasipuram, Salem (Dt.)
64. Ullagappa Udiar, Sago Factory,
Kalangani, Puduchattram (P. O.), Salem.
65. C. Duri Swamy Udiar, Sago Factory,
Kalangani, Puduchattram (P.O.), Salem.
66. T. S. Appayu Chettiar, Sago Factory,
Trichengodu, Salem (Dt.)
67. Imperial Starch Industries, Sago Factory, Mallur (P O.),
Salem (Tk.)
68. Muruganantha Sago Factory, Paravakkadu,
Patchiudiampalayam (P. O.), (*Via*) Rasipuram, Salem.

69. Ponmali Gounder, Sago Factory,
Pudupatti (P. O.), (*Via*) Rasipuram, Salem.

70. M. Periasamy Achari, Sago Factory,
Thimmanaickanpatti, Attur (Tk.), Salem.

71. A. R. Ramasamy Gounder, Sago Factory,
Iyampallayam, Vadugam (P. O.), Salem (Dt.)

72. S. Atthiappa Gounder, Sago Factory,
Kailasampalayam, Vadugam (P. O.) Salem (Dt.)

73. R. Kumara Swamy Gounder, Sago Factory,
Kerranur, Mallur (P. O.), Salem.

74. A. Perumal, Sago Factory, Kalangani,
Puduchattram (P. O.), Salem.

75. Solamuthu Udiar, Sago Factory,
Kalangani, Puduchatram (P. O.), Salem.

76. N. Arunachala Udiar, Sago Factory,
Ayodhiapatnam, Salem.

77. Pomali Udiar, Sago Factory, Ayodhiapatnam, Salem.

78. A. Manickam, Sago Factory, Ayodhiapatnam, Salem.

79. L. Kuppusamy Gounder, Sago Factory,
Ayodhiapatnam, Salem.

80. K. Chinnathambi Udiar, Sago Factory,
Minnampally, Karipatti (P. O.) Salem.

81. Perianna Chettiar, Sago Factory,
Udiappatti (P. O.) Salem.

82. K. Kaliathu Udiar, Sago Factory.
Minnampally, Karipatti (P. O.), Salem

83. A. Natasam Pillai, Sago Factory,
Mallikari, (Via) Attur, Salem.

84. A. Mariappan, Sago Factory,
Bodinaickenpatti (P. O.) (Via) Namakkal, Salem.

85. S. Arrappali, Sago Factory,
Bodinaickenpatti (P. O.) (Via) Namakkal, Salem.

86. C. M. P. Atthiappa Gounder, Sago Factory
Pudupet, Attur, Salem (Dt.)

SAGO

Starch is one of the most abundant materials in the vegetable kingdom. It occurs as small granules in the cells of all plants, barring the *fungi*. It is generally obtained from grains like rice, maize, etc. It is also extracted from the palms, tubers and roots of various plants. Every species of starch has its particular form and structural markings, which can be detected by microscopical examination.

Starch when moistened and mechanically shaken, turns into globules. Such globules, when roasted and dried, give the product called *sago*. The basic fact to be recognized is that sago is just a processed or partially precooked food starch, and not a cereal.

Sago was first prepared by kneading the pithy interior of the sago palms, (*Metroxylon rumphii and Metroxylon sagus*) with water. Sago globules are now being made from starch derived from various sources, besides the sago palm. At the Central Food Technological Research Institute, Mysore, globules have been made from most of the common starches. The root starches have been found to have several of the properties of palm starch. From the point of view of practical nutrition, one starch can replace another. Sago globules made from different starches will therefore have similar properties.

However, there is an important distinction between the sago prepared from cereals and that prepared from roots and tubers. The sago prepared from grains like rice, wheat, *jowar*, maize, etc., cooks somewhat slowly and yields an opaque product resembling cooked rice. The sago made from the starches of roots and tubers as well as different palms cooks fairly quickly into a slightly sticky and translucent mass. It is on account of this that the tamil name "Javvarisi" (sticky rice) has been given to such a product. "Sagodana" and "Sabudana" are two other Indian appellations for sago.

Palm starch sago is not produced at present to any large extent in the world. The very countries that were preparing and supplying palm starch sago to India appear to have switched

over to tapioca starch, some decades back. When supplies to India stopped, consequent on the second World War, India started the manufacture of sago following the methods then adopted in other countries like Indonesia and Malaya. Sago from tapioca starch has thus been on the Indian market for the past 15 years or so. People in different parts of the country have been consuming the product without any complaint whatsoever, until recently.

Sago is usually made into gruel and given to infants and invalids. Therefore, the marketed sago should be of good quality and free from extraneous impurities, micro-organisms, etc. The product prepared and sold at present by the sago manufacturers in Salem and other places is generally satisfactory. However, suggestions for further improvement of the product and the processes followed in sago manufacturing units, both big and small, have been made in the following pages for the benefit of the sago industry.

DEFINITION AND STANDARDS

Sago has been defined by different States as follows:

BOMBAY—Sago means a starch product derived exclusively from Sago palms (*Arenga saccharifera*, *Metroxylon Rumphii*, *Caryota urens*, *Metroxylon laeve*, *Metroxylon sagus*, *Metroxylon koenigii* and other allied species) and free from foreign starch and matters such as lime, talcum, etc.

PEPSU—A starch obtained from the pith of certain species of palms. The starch granules must have the characteristic appearance under the microscope.

PUNJAB—The same as above.

TRAVANCORE-COCHIN (TRAVANCORE)—"Sago" is the starch derived from the pith of several varieties of palm trees (genera *Metroxylon*, *Arenga and Borassus*), indigenous in the East Indies.

MADRAS—Sago means the starch product prepared from the rhizomes of tapioca otherwise known as cassava, or from the pith of the sago palm and includes sago in any form, including flour, pearl, globule and flake. Sago shall be free from any

foreign substance, including artificial colouring matter, coating, facing or glazing substance.

CENTRAL COMMITTEE FOR FOOD STANDARDS, Government of India, at its third meeting held in 1942 recommended the following definition of sago :

" Sago is the product derived exclusively from Sago palms (*Arenga saccharifera*, *Metroxylon Rumphii*, *Caryota urens*, *Metroxylon laeve*, *Metroxylon sagus*, *Metroxylon koenigii*) and other allied species". The Committee at its 7th meeting held in 1953 reexamining this point recommended that Sago made from tapioca starch should be termed " Tapioca Globules." However, the same Committee at its 8th meeting held in February 1954 adopted that" Sago is product derived from sago palm (*Species Metroxylon*) or from tapioca root (*Manihot utilissima*).

The term " tapioca glouble " for the sago made from tapioca is likely to give a wrong interpretation to the composition of the product. Whole tapioca flour, or the white flour obtained from tapioca after removal of the two skins, can also be rolled into globules. Such a product would be a typical globule. However, the product as now manufactured by the industry is from the starch extracted from tapioca. In fact, it may be said that the preparation of starch is the major process in the manufacture of sago. The term " tapioca globule " would therefore be technically wrong and would apply to another type of product that can be made from the tapioca tubers. Hence, " tapioca sago " may be a more appropriate name for the product.

Physical and chemical standards for Sago have been prescribed by only three States *viz.*, PEPSU, Punjab and Madras and are given below :—

Sl. No.	Authority	Moisture not more than (%)	Ash not more than (%)	Carbohydrate not less than (%)	Protein not less than (%)
1.	Pepsu	12.0	0.1	87.0	0.20
2.	Punjab	12.0	0.1	87.0	0.20
3.	Madras	—	0.1	—	—

PRESENT STATUS OF THE INDUSTRY

The Indian Sago industry is mostly located in the Salem District of the Madras State. There are about 100 units in Salem and other parts of the Salem District, which are engaged on the manufacture of sago. There are about 15 units in other districts of the Madras State and in Travancore-Cochin.

The annual production of sago in India varies depending on factors such as busy and slack seasons, availability of the raw material and consumer demands. According to the Report of the Tariff Commission, Government of India 1954, the annual production of sago is about 18,000 tons. In Salem District, the industry employs about 6,000 people, mostly women, on a regular basis, and several thousands as casual labour for the peeling of tapioca and for other jobs. The value of the annual production also fluctuates and depends upon the price fetched by the product in the market. While at the present time, the best quality of sago fetches about Rs. 38/- per bag of 205 lb. (f. o. r. Salem), at one time the price was as high as Rs. 150/- per bag. The units in Salem District are reported to have capacities of 10–100 bags of sago per day. The bigger units are located in big buildings while the smaller ones are worked in thatched sheds built for the purpose.

ORIGIN OF THE INDUSTRY

The Sago industry owes its origin to the exigencies of the Second World War when supplies from Java, Malaya and other countries were cut off Some of the manufacturers who had come over to India from those countries taught the method of preparation to a few persons. The first factory was set up in Trichur (Travancore-Cochin State) by a private firm. However, this factory had to close down with the imposition of embargo on the export of tapioca products from Travancore-Cochin. It was at this time that a few units were started in Salem. The climatic conditions for a large part of the year being favourable for the drying of starch and sago,more factories came to be established in Salem District which soon became

the main centre for sago production. Credit should go to the sago manufacturers of Salem for starting the Industry, designing and building a large part of the equipment, training the personnel and setting up a big organization for effecting the sales.

RAW MATERIAL

The Sago palms are a native of the E. Indian Archipelago and flourish in low, marshy situations. They seldom grow to a height of 30 feet and have thick-set trunks. They attain maturity and produce an inflorescence at the age of fifteen years, when the enormous pith of the stem is gorged with starch. If the fruit is allowed to form and ripen, the whole of this starchy material passes into the developing fruits, leaving

The Tapioca plant (*Manihot utilissima.*)
The inset shows the tubers.

the stem a mere hollow shell. Accordingly, the palms are cut down directly the inflorescence appears and the starch extracted.

As years passed by, the manufacture of sago from the palm became difficult and expensive and the different countries which were once making the product from the palm gradually started the use of tapioca (Cassava), which proved a cheaper and more abundant raw material. The sago imported into India shortly before the II World War was primarily from tapioca.

The area under tapioca and the production in the Madras State for the five years 1948–49 to 1952–53 are given below :

Year	Area (acres)	Production (100 maunds)
1948–49 ...	41,930	39,098
1949–50 ...	49,750	46,353
1950–51 ...	76,470	71,356
1951–52 ...	74,486	69,246
1952–53 ...	131,100	123,847

(*Director of Agriculture, Madras*)

Malabar district alone accounts for nearly 79 per cent of the total area under the crop, while Salem, the second largest tapioca-growing district, has nearly 13 per cent of the total acreage. The area under the crop has maintained a steady increase from year to year (excepting 1951-52). The increase in acreage in the Madras State in 1952-53 was 56,614 acres over that of the previous year (which is nearly 43 per cent), Malabar and Salem contributing 38,723 acres and 17,616 acres respectively.

The following tables give the area and production of tapioca in the world as well as different States in India.

AREA UNDER CASSAVA (TAPIOCA)

(*Based on the actual acreage of countries in F. A. O.*)

Continent	Area in thousand acres			Average
	1949	1950	1951	
Central America	163	306	121	197
South America	3052	2696	2466	2738
Asia	2891	2676	2654	2740
Africa	5481	6971	4428	2756
Oceania	30	20	17	22
Total	11617	12669	9686	12324

PRODUCTION OF CASSAVA (TAPIOCA)

(*Based on actual production in F. A. O. countries*

Continent	Production in thousand tons			Average
	1949	1950	1951	
Central America	212	452	153	227
SouthAmerica	15290	13736	12064	13697
Asia	8090	7974	8222	8096
Africa	14467	22703	12751	16640
Oceania	97	58	53	69
Total	38156	44923	33243	38774
	(7357)	(7943)	(7688)	(7670)

Figures in brackets represent yield per acre in lb. Total for different continents are only for those countries where both acreage and production figures are available.

Source : Year-book of Food-Agricultural Statistics, 1952, Vol. IV, Part (Production).

AREA UNDER TAPIOCA IN DIFFERENT STATES IN INDIA

State	Area (acres)		
	1949-50	1950-51	1951-52
Assam	2600 **	2613	2800
Madras	51947	72869	72869 **
Orissa	232	344	344 **
West Bengal	NA	100	NA
Hyderabad	,,	325	,,
Mysore	169	173	173 (a)
Travancore-Cochin	NA	514287	514287
Coorg	26	514	46 (a)
Kutch	NA	46	152
Tripura	NA	500	500 (a)
Total	54974	591771	591171

PRODUCTION OF TAPIOCA IN DIFFERENT STATES IN INDIA

State	Production (tons)		
	1949-50	1950-51	1951-52
Assam	6035 ‡‡	2667	2057
Madras	163110	226500	226500 ‡‡
Orissa	2249	3367	3367 ‡‡
West Bengal	NA	918	NA
Hyderabad	NA	1625	NA
Mysore	315	150	316 (a)
Travancore-Cochin	NA	1446253 (a)	1446253
Coorg	89	2050	167 (a)
Kutch	NA	167	150
Tripura	NA	2500 (a)	2500
Total	171798	1686197	1681310

NA = not available ; (a) = estimated ; ‡‡ = Data for the preceding or following year have been repeated.

Source : Estimates of area and production of principal crops in India-1951—52, issued by the Economic and Statistical Adviser, Ministry of Food and Agriculture, Government of India.

PROCESS OF MANUFACTURE

The manufacture of sago, as generally followed in Indian factories, comprises the following steps :

(1) Washing of the tubers to remove adhering dirt.
(2) Peeling of the tubers to remove the two skins.
(3) Washing of the peeled product.
(4) Disintegration of peeled material into a fine slurry.
(5) Straining of the slurry to separate the fibrous matter from the starch.
(6) Sedimentation of the starch.
(7) Draining of surplus water and washing of the starch.
(8) Partial sun-drying of the starch.
(9) Formation of globules by shakers.
(10) Size grading of globules.
(11) Roasting of the granules with a thin coat of oil.
(12) Heaping and final sun-drying of the roasted product.
(13) Mechanical breaking of clumps formed during roasting.
(14) Sorting and packing.

Cleaning of tubers in water

Peeling of tubers

Peeling of the tubers is done by labourers with the help of knives. The peeled tubers are washed in reservoirs containing water and crushed finely in mechanically operated disintegrators. The resultant pulp slurry is allowed to run over a long strainer (made of cloth or wire-mesh) and the fibrous matter removed by manual labour. The fibrous matter is dried and used as a cattle feed. The starch milk obtained after the straining is allowed to settle down either in settling tanks or by the tabling system. The supernatant water is drained and the sedimented starch washed once or twice and then spread over cement yards or barbecues, and partially dried in the sun. Granulation of this starch (which still has 50 per cent

Straining of the pulp slurry

Starch table

moisture) is done by rubbing it through 12-16 mesh sieves and converting it into globules. Globulation is done by shaking in cloth bags by manual labour in the smaller factories, and by the use of power driven shakers(with wire screens) in the bigger factories. The globules are graded according to size and then roasted. In all the factories, the final roasting is done by skilled labour. Then the roasted products are sun-dried. Clumps formed during the roasting are broken manually or by mechanical means. The packing of the sago is done in gunny bags.

Although it is recognized that under the limitations of finance, equipment and technological information available to them, the Sago manufacturers have generally been able to utilize the resources fairly efficiently, a study of different operations in the Salem factories reveals that several improvements are necessary and desirable. Some of these are discussed later in this brochure.

YIELD OF STARCH

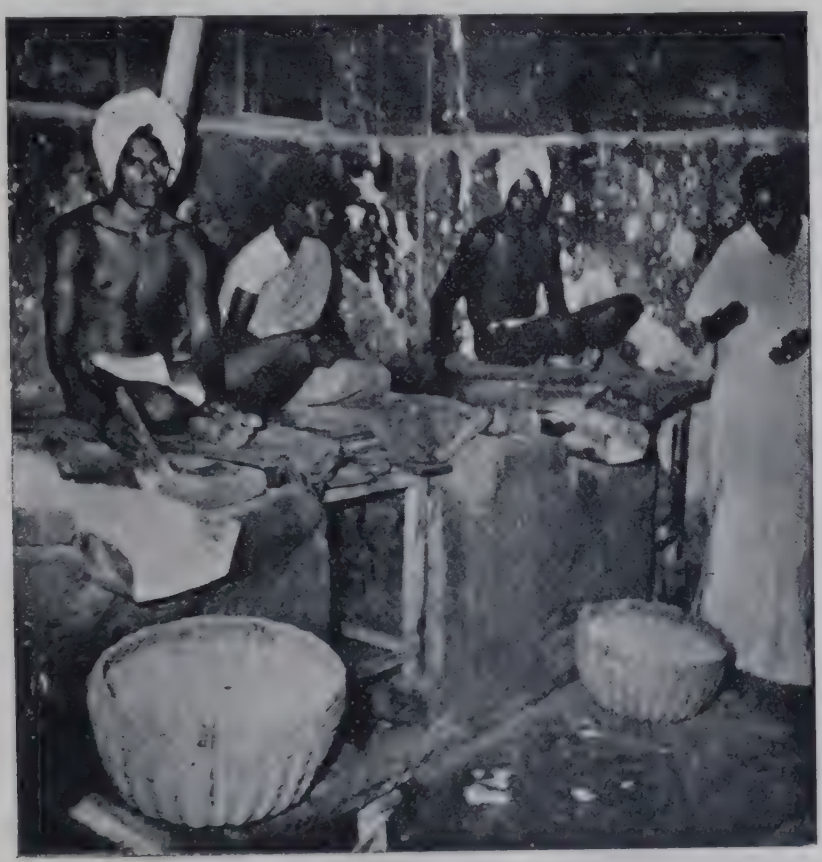
The most important factor affecting the cost of production of sago is the price of tapioca tubers. At one time, the

A settling tank

***Formation** of globules by mechanical shaking*

price was as high as Rs. 220 per ton, but it has now come down to about Rs. 65 per ton (*i.e.* to less than $\frac{1}{2}$ anna per lb.)

Raw tapioca contains 35-40 per cent solids, of which starch accounts for only 25 per cent. The sago manufacturers report that they obtain over 20 per cent yield of starch. A certain amount of starch is usually lost along with the fibre and in the discharged water due to imperfect disintegration, incomplete sedimentation, etc. As the final sago also contains some water, the yield of the product that is marketed may be estimated at about 25 per cent of the fresh weight of tapioca.



Gelatinization of wet globules

NUTRITIVE VALUE AND USES

The sago of commerce consists of starch, some associated calcium and other minerals. If the process of manufacture is not efficient, it may also contain varying amounts of sugar acids, fibre, nitrogenous impurities, mineral matter, grit, etc.

In regard to the unmodified starches, there is evidence to show that those from grains and tapioca are digested to a greater extent than those from potato, arrow-root or

sago palm.* Studies on the digestibility of sago prepared from different raw materials are in progress at the Central Food Technological Research Institute, Mysore.

Sago is used in many homes in India for the preparation of puddings and other dishes. It is also used as an invalid food. The product is largely used especially in West Bengal. In Bombay and a few other places, there is a good demand for the product during the month of *Shravan*, when a large number of fasts are observed by a section of religious people.

Different savouries and sweets can be prepared from sago. When admixed with milk or buttermilk, it becomes a more balanced form of food. Some recipes of sago preparations have been given in Appendix. I

SUGGESTIONS FOR IMPROVEMENT

STORAGE LIFE OF THE RAW MATERIAL

Although Salem District has a large area under tapioca, substantial quantities of the tuber have to be imported from Malabar during certain seasons, especially when the monsoons fail, to meet the demands of the sago factories. If tapioca could be purchased during periods when it is in plenty and stored for some time, it will greatly help the sago industry. This has not been possible, however, till now, as the tubers have a tendency to perish quickly and easily.

A casual inspection of the tubers used in different factories shows the presence of bacteria and fungi. These organisms penetrate the tuber especially through injured portions which do not dry readily to form protective coats. Also, quite a lot of infection seems to be present in the soil in which the crop is sown.

The Central Food Technological Research Institute, Mysore, has carried out systematic studies with a view to prolonging the storage life of the tubers. The Institute has found that the spoilage caused to the tapioca tuber within 3-4

* " Biological utilization of unmodified and modified food starches by Booher, L. E., Behan, J. and McMeans, E , *J. Nutr* , 1951, 45, 75.

days of the harvest by fungi can be checked with a mixture of ethylene dibromide and ethyl bromide. Treatment of the tubers with the vapours of these fumigants (at 8 lb. / 1000 c. ft. rate) preserves them without spoilage for 25 days.

The possibilities of using the dry tapioca chips for the preparation of starch is being investigated at the Institute.

PEELING OF TAPIOCA TUBERS

Peeling of the tapioca tubers forms the first operation in the manufacture of Sago.

The sheds where the peeling operation is done should preferably have cemented floors with a gentle slope and should be provided with wooden benches in straight rows. In this way, an orderly seating arrangement of the labourers engaged on the job will be made possible and thorough cleaning of the working shed facilitated. Economy in space will also be effected and a better supervision of the work of the labourers made possible.

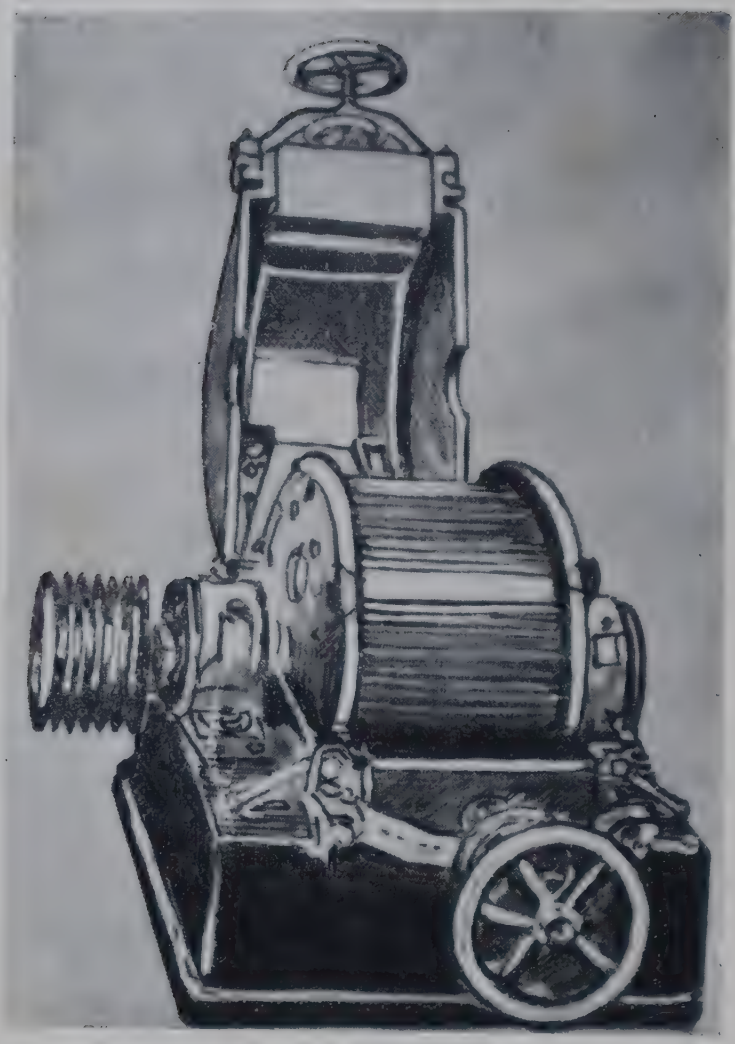
DISINTEGRATION & TABLING

Recovery of starch, comparable with those in large modern factories, cannot naturally be obtained with the comparatively inefficient disintegration of tubers with the equipment and practice existing in the small factories in Salem area. A fair amount of starch is usually lost along with fibres. Further, there is a cetain loss of the starch in the effluent because of the present methods of sedimentation.

Some factories have introduced the tabling system but they are not along recognised lines with the result that the liquid either flows too fast or stagnates too long.

The raspers employed for disintegration at present are rather crude. Modern saw-tooth raspers now used in Western countries in potato and tapioca starch plants will obtain better recoveries and are recommended for use.

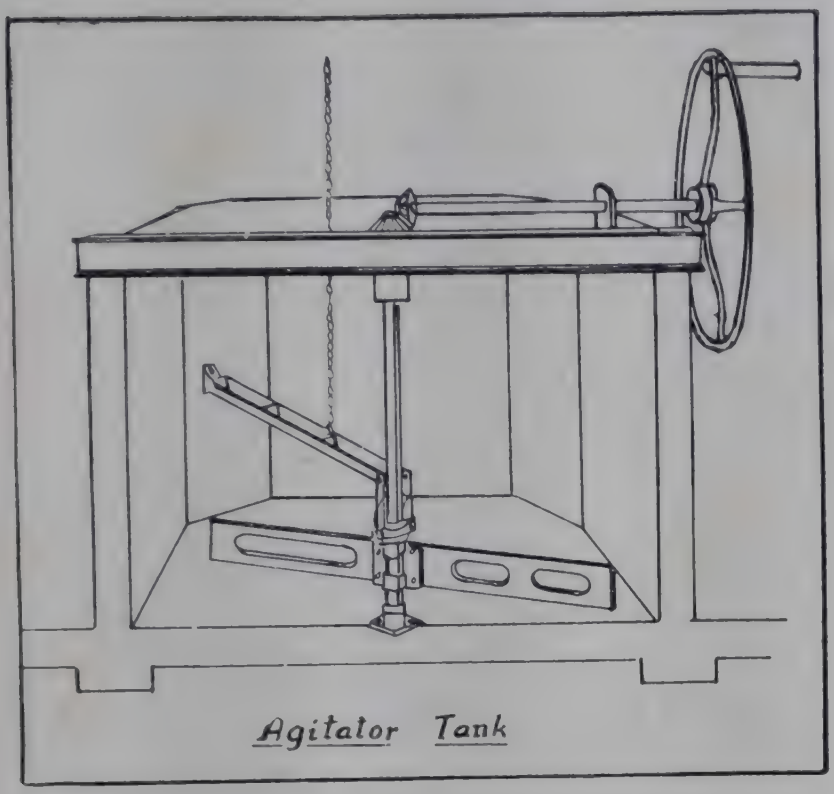
During sieving, rubbing is done by hand. It is desirable to use suitable brushes even when manual labour is used for the screening operation.



A modern rasper for grinding tubers

The bottom layer of sedimentation tanks and tables may contain a certain amount of grit along with the starch. In addition, the discharge from the sedimentation tanks leaves, on standing, a deposit of starch. This constitutes an inferior starch and can be reclaimed by re-sedimentation or tabling to obtain starch of a passable grade.

Very often, the starch does not settle properly in the tanks and gets lost along with the effluent. The practice in some factories is for the labourers to get into the tanks or tables and paddle with their limbs to stir the contents. It is very necessary to discourage this practice. Use of mechanical puddles will give good results.



Agitator Tank

CHECKING FERMENTATION IN SETTLING TANKS

Fermentation often occurs in settling tanks and is caused by putrefactive and gas producing organisms present in the air, water, adhering dust and the tubers. This can be checked by using a safe preservative like sulphur dioxide in suitable concentrations. Sulphur dioxide may be used either as gas or in the form of potassium and sodium bisulphites or metabisulphites. However, where production warrants, the cheapest method of using sulphur dioxide would be to burn sulphur in special burners.

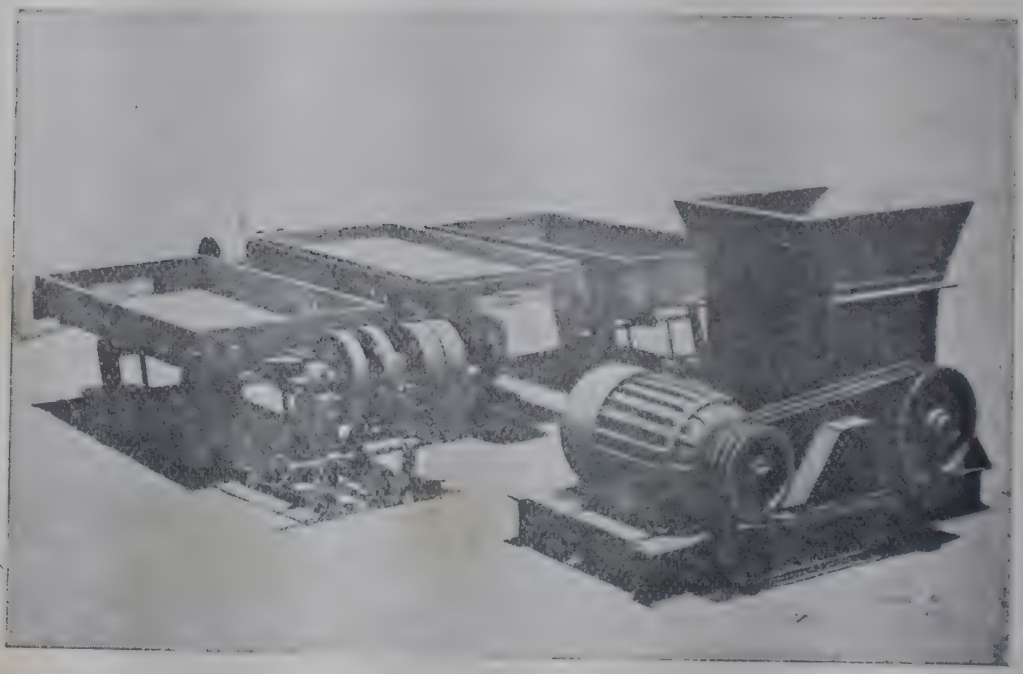
DRYING OF STARCH

The pasty mass that settles at the bottom of the sedimentation tanks is lifted and spread over specially constructed yards or barbecues for sun-drying. The method of collection and spreading of the product as well as the breaking up of any clumps that may be formed are not hygienic at present. Naked

hands and feet are used in the collection of starch. The drying yards instead of being wide and extensive may be divided into compartments and provided with walking space all round. The spreading, raking and collection of the starch may be done by shovels with long handles.

GLOBULATION, ROASTING AND DRYING

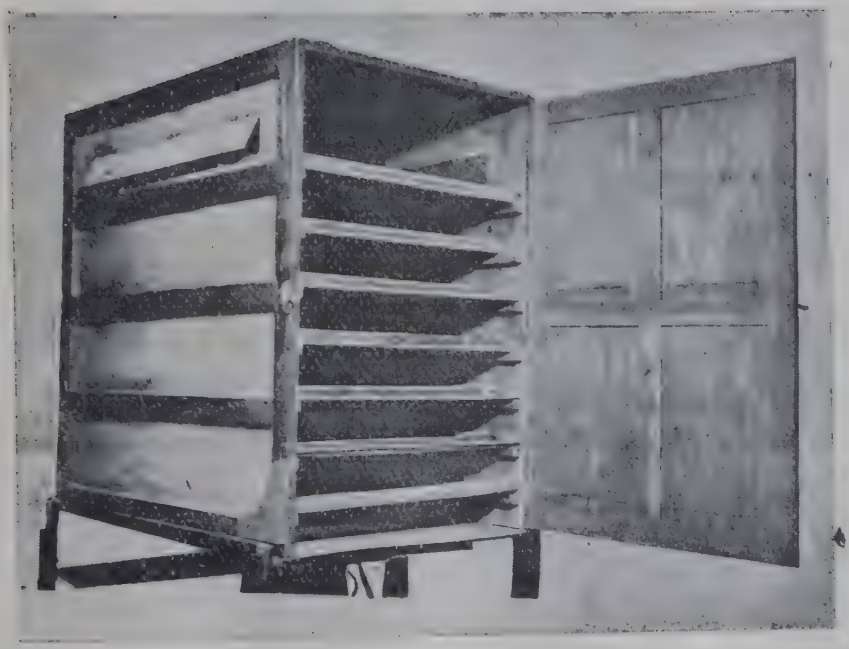
For the preparation of globules, power driven reciprocating shakers or cloth hammocks manned by labour are used.



Small-scale globules–formation unit fabricated at the Institute.

The roasting operation is generally done by skilled labour. Yet, over-heating is often noticed at the bottom and certain parts of the grain do not also get properly gelatinized. A satisfactory sago globule should have its surface starch uniformly well gelatinized. Such a product will be hard and will preserve its form even after cooking.

An efficient gelatinizer would be a rotary type of equipment in which uniform heating is obtained. Such an equipment has been tried for small-scale work at this Institute and the fabrication of similar equipment of bigger capacities should not be difficult. Such roasters can be fitted up with



A cabinet drier for drying sago

arrangements for drawing in air so that partial drying of the sago can be done after gelatinization. This would reduce clumping to a minimum.

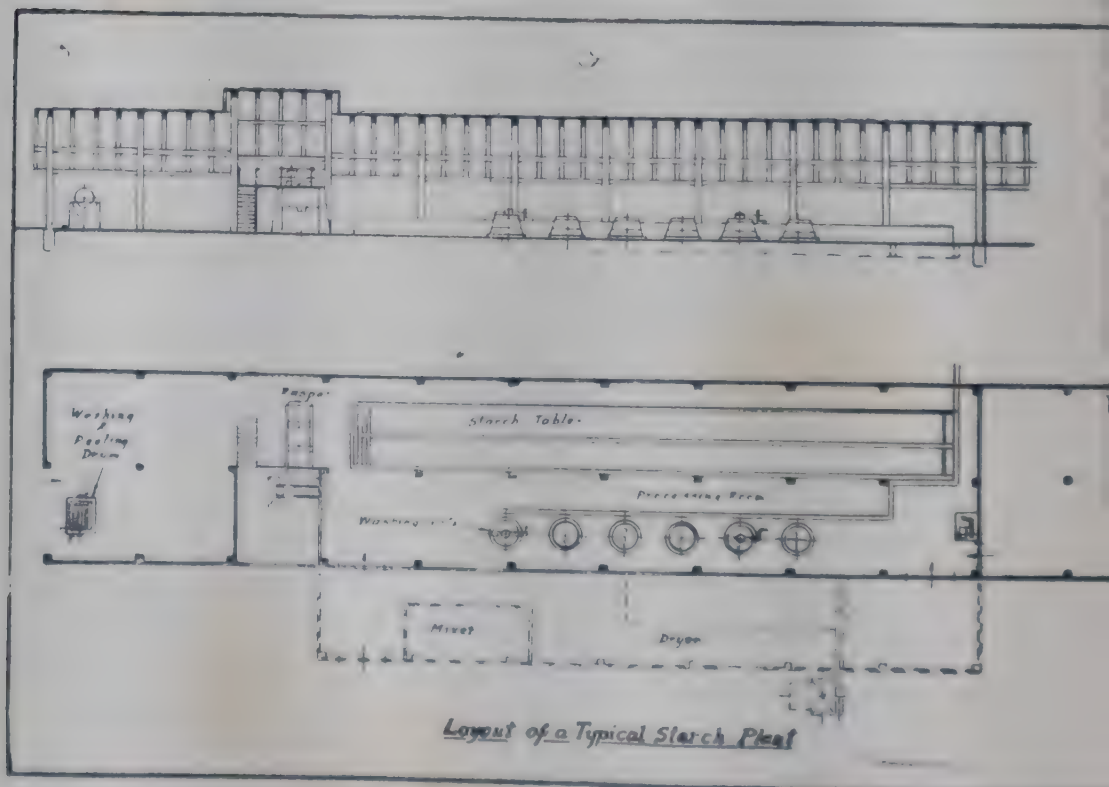
Tapioca sago

At the present time, roasted sago is first heaped for some time to allow it to cool a little and to harden. Then it is spread out on the barbecues for drying. However, while collecting the dried sago, the workers usually trample over it. This

Storage of sago in jute bags.

procedure should be stopped and could be avoided if the sago is also dried in closed systems like tray driers.

The dry sago can be stored in jute bags impregnated with insecticides. The layout of modern Tapioca Sago Factory is given below.



Layout of a Typical Starch Plant

BY-PRODUCTS

The quantity of fibre present in the tuber depends on the variety and age of the tapioca at the time of harvest. The amount of fibre left on the sieves varies from factory to factory. The fibrous material may contain 25-30 per cent starch but some batches may contain even more. Apart from the starch, the major constituent of the fibre is a hemicellulose.

The fibre is generally used as a cattle feed or fuel, and the price fetched by it is negligible. At one time, when there was grain shortage, the fibre admixed with tapioca flour is said to have been used for preparing different food products. A blend of the fibre and groundnut cake is reported to be sold as a balanced animal feed. Adhesives and distempers are a few other products that can be prepared from the fibrous material.

GENERAL

Testing Unit—There is urgent need to lay down complete standards for sago and organize a testing unit to examine every batch of the product that is marketed. The unit should examine only numbered specimens and no manufacturer should have direct access to it. It may be located at a place, away from the manufacturing centres, like the Central Food Technological Research Institute, Mysore, which is already doing similar work for the fruit and vegetable products sold in the country.

Allied Industries—The sago industry should not rest content with manufacturing only one product but should also try to develop a number of allied industries.

Advisory Board—The sago industry has come to stay but needs further strengthening. It should organize itself as a stronger and more unified Body and map out its future development, on sound lines. A small Advisory Board consisting of members of the industry, representatives from the Central and State Governments and a few technical experts should be formed. The Board should meet periodically, discuss the problems of the industry and organize its future expansion and development.

APPENDIX I

RECIPES FOR SOME SAGO PREPARATIONS

1. Sago Pudding (*Khir*)

Ingredients

Milk: 1 *lb* (2 cups); Sago: 1–1½ *oz.*; Sugar: 2 *oz.*;

Flavour (essence): *according to requirements.*

Method

Boil milk for 15-20 minutes when it concentrates to some extent. Add the requisite quantity of sago to the boiling milk and cover the container with lid.

Stir the grains to avoid clumping.

Cover again and continue heating.

Add sugar when the grains soften well and the consistency of the product is neither too thin nor too thick.

Stir well and continue heating till the desired consistency of the finished product is obtained. Remove from the fire and add essence and colour, if necessary. Mix properly and cover again. Use the product as a sweet dish.

2. Sago Gruel (*Kanji*)

Ingredients

Milk: 2 *lb* (4 cups); Sago: 1½ *oz.*; Sugar: 4 *oz*,; Flavouring material *according to requirements.*

Method

Heat the milk to boiling.

Add the sago to the boiling milk, stir properly and cover the container.

Add sugar when the sago is cooked well. Mix well taking care that the product does not get mashed.

Remove the vessel from the fire after 2-3 minutes.

Stir gently and add the flavouring material.

Use the finished product as *Kanji* for invalids.

3. Sago *Payasam*

Ingredients

Sago: 1 *table spoon*; Milk: ½ cup; Sugar 4 *table spoons*; Water: 2 *cups*; flavouring materials: (saffron, cardamum, cloves, Cashewnuts, dried grapes): *as desired.*

Method

Boil water, add sago to it and cook till the sago becomes transparent. Add sugar and milk and stir. Boil for a few minutes and remove from fire. Fry the cashewnuts and dried grapes in a little *ghee* and add it to the cooked mass. Add all the condiments and serve hot.

4. Sago *Kesari*

Ingredients

Sago: 1 *cup;* Water: 2½ *cups;* Sugar: 2½ *cups;* Ghee: ½ *cup;* Cashewnuts, dried grapes and spices: *small quantities, as desired.*

Method

Roast the sago a little. Then add water and allow the sago to cook well. Add sugar, *ghee*, cashewnuts and grapes and mix thoroughly. Heat till bubbles come out of the mass. Add spices and serve hot.

5. Sago *Uppuma*

Ingredients

Sago: 4½ *oz.;* Ghee: 2-3 *table spoons*; Black gram dhal: 1 *tea spoon*; Water: 1 *cup*; Salt: 1½ *tea spoons*; Condiments (green chillies, onion, mustard, asafoetida, curry leaves and fried cashewnuts): *as desired.*

Method

Heat the *ghee* and fry the mustard, blackgram dhal, chillies and curry leaves. Chop the onions and fry. Pour water and add salt and asafoetida. Fry the sago separately and drop it in the water, when it boils. Mix well. Stir occasionally and cook till the sago is soft. Serve hot.

6. Sago *Vaangibath*

Ingredients

Sago : 2 *cups;* Water : $2\frac{1}{4}$ *cups;* Brinjals : 3; Vaangibath masala: 2 *spoons;* Blackgram dhal: 1 *spoon;* Bengalgram dhal: 1 *spoon;* Oil : 4 *spoons;* Mustard, asafoetida, grated coconut, chillies, ginger, turmeric powder, cashewnuts, curry leaves: *small quantities as desired.*

Method

Roast the sago on slow fire in the *ghee* for about half an hour. Remove from the fire and soak the sago in water for about quarter of an hour. Heat the oil and fry in it the mustard, Bengal gram dhal, black gram dhal and cashewnuts. Then add the sliced brinjal, chopped ginger, turmeric powder, salt and curry leaves. Stir well and after 5 minutes add the soaked sago, vaangibath masala and grated coconut. Mix thoroughly and cook for about 10 minutes on slow fire. Squeeze half a lime and add a few drops to the finished product, *Vangibath*, and serve hot.

7. Sago Curd *Bhath*

Ingredients

Sago : 2 *oz;* Curd : 4 *oz;* Ghee . 1 *spoon;* Salt : $\frac{3}{4}$ *spoon;* Mustard ginger, green chillies, curry leaves, coriander leaves, asafoetida : *small quantities as desired.*

Method

Roast the sago in the ghee for about 5 minutes. Soak in water for about 15–20 minutes. Beat the curd and drop the sago into it. Stir well. Fry the mustard, chillies (sliced) ginger (chopped), curry leaves and asafoetida and mix with the sago in curd. Serve warm or cold as required.

8. Sago *Boondi*

Ingredients

Sago : 2 *cups ;* Ghee : $\frac{1}{4}$ *cup*; Chilli powder and salt : *small quantities as desired.*

Method

Fry the sago in *ghee* till it becomes brown. Add chilli powder and salt. Remove from fire and serve.

9 Sago *Vadam* (*Pappad*)

Ingredients

Sago: 1 *cup;* Water: 3 *cups;* Lime: $\frac{1}{2}$; Salt: 2 *oz;* Asafoetida
d chillies : *small quantities as desired.*

Method

Drop the sago in boiling water. Stir well and continue
iling till the sago gets cooked. Remove from fire and add
it a ground paste of the salt, asafoetida and chillies. Then
ueeze the lime and add the juice also. Stir well and boil again
necessary, till a thick soup-like liquid, (which will flow slowly
hen spread) is obtained. Spread 1–2 spoonfuls on either,
oth or leaf and dry in sun. After 24 hours remove the
ied pieces (wetting the cloth aids in the separation of the
eces), and dry again for about 12 hours.

Fry the pieces in oil and serve.

APPENDIX II

List of Sago Manufacturers

1. M. Venkatajala Gounder, Sundareswara Sago Factory, Nethymadu, Annathanapatti, Salem.
2. P. Manickam Chettiar, Starch Manufacturing Company, Sither Koil Road, Shevapet, Salem.
3. Sree Nataraja & Co., Sago Factory, Post Box No. 74, Shevapet, Salem.
4. P. Elumali Gounder, Sri Shunmuga Sago Factory, Leigh Bazar, Salem.
5. K. S. Shunmugam Chettiar, Sago Factory, Peria Eluthagara Street, Shevapet, Salem.
6. E. R. Perumal Chettiar, Sago Factory, Shevapet, Salem.
7. E. R. Subaralu Chettiar, Sago Factory, Shevapet, Salem.
8. T. M. Visvanatha Chettiar, Sago Factory, Shevapet, Salem.
9. S. Thangavelu, Sago Factory (Standard Sago Factory), Shevapet, Salem.
10. E. R. Vengatajalam Chettiar, Sago Factory, Shevapet, Salem.
11. S. Santhanam Chettiar, Sago Factory, Shevapet, Salem.
12. K. Jagannathan Mudaliar, Sago Factory, (Rama Rice Mill), Shevapet, Salem
13. T. S. Aiyavo Chettiar, Sago Factory, Leigh Bazar, Salem.
14. S. Manicka Mudaliar, Sago Factory, Leigh Bazar, Salem.
15. E. C. Mannar Chettiar Sons, Chinna Krishna Sago Factory, Pallapatti, Salem.

6. Sri Murugan Sago Factory, Maiyanur, Salem.
7. S. Anthonisamy Mudaliar, Jothi Sago Factory, Pallapatti, Salem.
8. P. Ranga Samy & Co., Sago Factory, Gandhi Nagar, Salem.
9. T. K. Muthiyal Chettiar, Sago Factory, Santhipet Main Road, Shevapet, Salem.
10. Raja Rajeswari Sago Factory,(R. Raju Chettiar), Shevapet, Salem.
11. V. Thirupathi Chettiar, Sago Factory, Ommalur Road, Srisipalayam, Salem.
22. Mahatma Sago Factory, Gandhi Nagar, Pallapatti, Salem.
23. T. M. Muthu Narayana Chettiar & Bros., Sago Factory, Shevapet, Salem.
24. S. T. N. Ramakrishnan, Sago Factory, Shevapet, Salem.
25. A. Rajagopal Chettiar, Sago Factory, Singarapet, Shevapet, Salem.
26. A. G. Sasham Chettiar & Sons, Sri Venugopal Rice & Sago Mill, Namagiripet, Salem. (Dt.)
27. A. G. Pethana Chettiar, & Sons, Sago Factory, Namagiripet (P. O.) Salem (Dt.)
28. K. T. S. Nagamanickam Chettiar, Sago Factory, Namagiripet, Salem. (Dt.)
29. K. Karuppana Gounder, Sago Factory, Dhavasdhanapudur, Namagiripet, P. O. Salem. (Dt.)
30. New Shumuga Sago Factory, Seerapalli, P.O., Salem (Dt.)
31. K. Periasamy Gounder & Co., Sri Murugan Sago Factory, Seerapalli, Namagiripet (P. O.), Salem. (Dt.)
32. S. Sundara Gounder, Sago Factory, Chinnakakkaveri, Namagiripet (P. O.) Salem. (Dt.)

33. Pera Kali Gounder, Gopalakrishna Sago Factory, Chinnakakkaveri, Namagiripet (P. O.), Salem (Dt.)
34. R. Muthu Swamy Gounder, Lakshmi Vilas Sago Factory, Ariyagoundampatti, Namagiripet, (P. O.), Salem (Dt.)
35. K. Rangaswamy Gounder, Krishna Vilas Sago Factory, Ariyagoundampatti, Namagiripet (P. O.), Salem (Dt.)
36. Varudappa Gounder, Sago Factory, Madanthagadu, Namagiripet (P. O.), Salem (Dt.)
37. Ponmali Gounder, Sago Factory, Seerapalli, Namagiripet (P. O.), Salem (Dt.)
38. K. Kalianna Gounder, Oriental Talkies, Seerapalli, Namagiripet (P. O.), Salem (Dt.)
39. Jayakrishna Sago Mill, Pro. Ramasamy Gounder, Vellakkalpatti, Namagiripet (P. O.), Salem (Dt.)
40. K. Muthu Gounder, Mannargadu Sago Mill, Pudupatti (P. O.), (*Via*) Rasipuram, Salem.
41. Atthiappa Gounder, Sago Factory, Kailasampalayam, Vadugam (P. O.), (*Via*) Rasipuram, Salem.
42. Palaniappa Gounder, Parayankadu Sago Factory, Aiyampallayam, Vadugam (P. O.), (*Via*) Rasipuram, Salem.
43. S. Arunachalam, Sago Factory, Pannamarathu Patti (P. O.), Salem (Dt.)
44. C. Kathamuthu Udiar, Dhanalakshmi Sago Factory, Sellappampatti, Namakkal (Tk), Salem (Dt.)
45. V. Rama Swamy Udiar, Sago Factory, Sellapampatti (P. O.), Namakkal (Tk.), Salem (Dt.)
46. P. Thayasayappa Udiar, Sago Factory, Budensanthi Sellappampatti (P. O.), Namakkal (Tk.), Salem (Dt.)
47. T. Nallaperumi Udiar, Sago Factory, Sellappamapatti, Namakkal (Tk.), Salem (Dt.)
48. A. Ramaswamy Udiar, Sago Factory, Sellappampatti (P. O.), Namakkal (Tk.), Salem (Dt.)
49. P. Kanda Sawamy Udiar. Sago Factory, Sellappampatti (P. O.), Salem (Dt.)

87. V. Mari Muthu Udiar, Sago Factory, Bodinaickenpatti (P. O.) Namakkal (Tk.), Salem.
88. C. Raju Udiar, Shunmuganantha Mills, Attur, Salem.
89. P. Kunchappa Chettiar & Sons, Sago Factory, Attur, Salem.
90. K. Natesa Udiar & Co., Sri Krishna Sago Factory, Newpet, Attur, Salem.
91. Atthiappa Gounder, C/o. Krishna Sago Factory, Attur, Salem.
92. M. Selvam Chettiar, Rajendra Mills, Pattukotti.
93. Anandha Sago Rice &Flour Mills, New Dharapuram Road, Kuparapatnam, Palani.
94. M. M. Yousaf Sahib, Sago Factory, Parangipet, South Arcot (Dt.)
95. Dasan & Co., Sago Factory, Parangipet, South Arcot (Dt.)
96. A. Perumal Pillai, Sago Factory, C/o. S. R S. Mills, Shoranur, S. Malabar.
97. A. V. Subramaniam, Sago Factory, Erode.
98. M. Vengataraman, Sago Factory, Erode.

List of Sago Merchants

1. Ashok Exporters & Importers, 23/24, Radhabazar St., Calcutta 1.
2. Bansidhar Dutta, 126, Khengraputty Street, Calcutta.
3. Bombay Malayan Traders, 38, Narayan Mudali Street, Madras.
4. Hiralal Debi Prasad, 43, Sir Hari Ram Goenka Street, Calcutta.
5. Shree Kisan Banarsilall, 1, Mullick Street, Calcutta.

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C. F. T. R. I. PUBLICATIONS

1. **Food and Population and Development of Food Industries in India** (*published in July 1952*) pp. xv+357.

This book brings together the views and suggestions of leading thinkers, industrialists, scientists, demographers and other experts on the two topics. Packed with up-to-date technical and statistical data on several food industries such as fruit preservation, biscuit, chocolate, confectionery, glucose, flour-milling, food yeast, vanaspati, edible oils, fish processing, food machinery and the refrigerated preservation of perishable foods, this authoritative document brings into relief the handicaps and potentialities of these Industries in India. An appendix embodying the recommendations of a Committee of Experts, and a comprehensive index enhance the usefulness of the book.

Price : Indian: Rs. 5-8 (*postage extra*); Foreign: 10 Shillings.

2. **Technical Aid to Food Industries** (*published in July 1954*), pp. xvi+270.

This publication contains the views and suggestions of prominent scientists, leading industrialists and food technologists, and Government officials on the nature of technical aid needed by different food industries in the country. Up-to-date technical and statistical data are provided and an appendix embodying the conclusions of the Symposium as well as a comprehensive index are given.

Price : Indian : Rs. 5 (*postage extra*) ; Foreign : 10 Shillings.

3. **Indian Food Laws** (*published in August 1954*) pp. v. + 220.

This volume summarizes all important details regarding the history, operation and enforcement of the food laws existing in different States in India, definitions, discriptions and chemical standards for articles of food including permissible additives, (colours, flavours and preservatives) and labelling